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A Valid, Culture-Fair Test of Intelligence

Joseph F. Fagan
Case Western Reserve University

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The question the present research addressed was whether a racially unbiased test of the ability to process information would predict how well young adults succeed in college classes. The technical barrier overcome was that current theories of intelligence are based on an assumption that all those taking IQ tests have had equal opportunity for exposure to the information being tested. Thus, past efforts to develop an intelligence test that is culture-fair have not been successful. The significance of the research is that it provides further evidence to evaluate a theory that defines intelligence as information processing ability (Fagan, 1992, 2000). Current research on a theory of intelligence as information processing finds racial differences in IQ to be due to cultural factors. A test of information processing is the first valid, culture-fair test of intelligence.

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Joseph F. Fagan
Case Western Reserve University

Basic Research Unit
Paul A. Gade, Chief

U.S. Army Research Institute for the Behavioral and Social Sciences
2511 Jefferson Davis Highway, Arlington, Virginia 22202-3926

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A VALID, CULTURE-FAIR TEST OF INTELLIGENCE

EXECUTIVE SUMMARY

The question the present research addressed was whether a racially unbiased test of the ability to process information would predict how well young adults succeed in college classes. The technical barrier overcome was that current theories of intelligence are based on an assumption that all those taking IQ tests have had equal opportunity for exposure to the information being tested. Thus, past efforts to develop an intelligence test that is culture-fair have not been successful. The significance of the research is that it provides further evidence to evaluate a theory that defines intelligence as information processing ability (Fagan, 1992, 2000). Current research on a theory of intelligence as information processing finds racial differences in IQ to be due to cultural factors. A test of information processing is the first valid, culture-fair test of intelligence.

Research Requirement:

The present research is based on a theory (Fagan, 1992, 2000) that assumes that we act on the basis of what we know. What we know is a result of our processing of the information provided to us by our culture. Based on these assumptions, the IQ score is seen as a measure of knowledge. Specifically, how much you know (your IQ) depends on how well you process information (your intelligence) and also on the information given to you by your culture to process. The theory has been used to explain the source of IQ differences between Americans of different races. Specifically, past research has found (Fagan & Holland, 2002, 2007) that American Whites and African Americans who differ in IQ do not differ in their ability to process information when that information has been equally accessible to both groups.

Procedure:

College students were given multiple choice tests of their ability to acquire new information concerning the meanings of previously unknown words, sayings, similarities, and analogies. They also were tested for their knowledge of vocabulary, opposites, and analogies with a brief version of the Scholastic Assessment Test-Verbal (SAT-V) constructed for the present contract. The brief SAT-V was constructed because some of the participants were community college students who are not required to take the SAT for admission to college and a standard measure of academic aptitude that would be common to both community college students and university students was needed. Numerical grades in courses were obtained for the majority of participants. Associations among performance on the culture-fair tests of new learning, academic aptitude (the brief version of the Scholastic Assessment Test scores), and specific achievement (objective test scores in college courses) were analyzed.

Findings:

The contract was undertaken to discover whether a measure developed to assess the ability to process new information is both valid and culture-fair. The findings reveal that tests of

new learning are culture-fair, reliable, and predictive of both academic achievement (numerical grades in class) and of a brief version of a standard test of scholastic aptitude (the Scholastic Assessment Test-Verbal). Further, the results demonstrate that tests of new learning and tests of existing knowledge (such as the brief SAT) each contribute independent variance to the prediction of class grades. A final notable finding is that the brief, 24 item version of the SAT-V that was created for the present investigation turns out to be as predictive of college grades as the standard SAT-V. In summary, the present research indicates that there are at least two factors that determine success in a complex learning environment such as higher education: one is information processing (new learning) ability and the other is the extent of knowledge one has acquired to that point.

Fagan (2000) assumes that the failure to develop tests of intelligence that can be fairly applied across racial groups stems from a theoretical bias to equate the IQ score with intelligence rather than with knowledge. If intelligence is defined as information processing and the IQ score as knowledge, the possibility of culture-fair tests of intelligence based on estimates of information processing arises. The chief theoretical implication of the results of the present research is that the assumption of equal opportunity for exposure to information made by theories of intelligence is false. When such an assumption is shown to be false, it becomes possible to develop culture-fair tests of intelligence that allow basic intellectual abilities to be recognized.

The general purpose of the present contract is *to add fundamental knowledge to behavioral science… and to discover general principles …* [through an] *integrated programmatic effort to develop and to test theory* (as called for by BRU in BRO-BAA, page 1). The specific goal is to discover the relationships among information processing ability and knowledge that lead to achievement and productivity in complex situations. The goal is in keeping with the Army's goal to improve its ability to *select, classify, train, and/or develop Soldiers and leaders who …are adaptable.*…[and who]…*can function effectively in …information rich…environments* (BRO-BAA, page 1, II, 1, a, b). One of the BRO-BAA Basic Research Areas of Interest is *leadership skills*. The research will aid in the goal of identifying *leadership skills in adaptability…when faced with novel situations* (BRO-BAA, page 4, III, C, 1). The research has resulted in a reliable, valid, and culture-fair test of intelligence based on the ability to process new information. The research aids in further demonstrating that *intelligence is a function of an aptitude* [learning ability in novel situations] *that cuts across domains and how to develop a method for measuring this aptitude* [and to further] *validate* [this] *cognitive ability against relevant criteria* (i.e., academic achievement), (BRO-BAA, page 5, III, D, 1).

In summary, the research is in keeping with the Army's goal to select Soldiers and leaders who can function effectively in information rich environments (BRO-BAA, page 1, II, 1, a, b) and to identify leadership skills as to adaptability when faced with novel situations (BRO-BAA, page 4, III, C, 1). The proposed research further aids in (1) demonstrating that intelligence defined as learning ability in novel situations is an aptitude that crosses domains and (2) validating this cognitive ability against relevant criteria (BRO-BAA, page 5, III, D, 1).

Utilization and Dissemination of Findings:

Two of the guiding missions of ARI, both historically and currently, are to provide new technology to meet the personnel challenges of the Army in recruiting, selecting, and assigning quality people and to provide scientific insight into leader development. The present research provides basic scientific data that may be applied by ARI to aid in *Soldier selection, assignment, and performance* and in *leader development.* The results of the present contract may lead to applied research that would be meaningful to the Army in the development of new, applied behavioral technologies to identify individual differences in cognitive ability that may be used in the selection of Soldiers and in the identification of mature, effective leaders. In addition, the proposed research will provide data to aid such selection and identification to be culture-fair with regard to gender and race. In general, tests of information processing ability that are valid predictors of achievement in complex situations will have important military applications. Such tests can aid in providing a valid means to evaluate volunteers and select candidates for advanced education or training in complex situations of the sort performed by Army personnel. Such tests also can be employed in further selection and training stages. In the field, such skills are necessary to make quick and correct decisions based on rapidly incoming information. Skill in information processing is likely to be a key indicator of effective future Army leaders. Finally, using tests of information processing known to be culture-fair may provide an increase in the number of eligible recruits and an incentive to re-enlistment on the part of minorities.

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Introduction

Current tests of intelligence are culturally biased. The purpose of the present research was to test the predictive validity of a culture-fair test of intelligence based on the ability to process new information. The present research evaluates a theory (Fagan, 2000) that defines intelligence as information processing ability. In theory, the IQ score is seen as a measure of knowledge resulting from processing ability and the information provided by the culture for processing. Brief tests of knowledge based on word meanings, similarities, sayings, and analogies that have recently been shown to be racially unbiased were administered to young adults. Associations between performance on culture-fair tests, academic aptitude (Scholastic Assessment Test scores), and specific achievement (grades in college courses) were analyzed. Practically, if culture-fair tests of information processing are valid predictors of achievement, such tests can aid in providing a culturally unbiased means to select candidates for advanced education or employment. Differences in IQ between African Americans and Whites are on the order of about 15 points (Jensen, 1985: Fagan & Holland, 2002). Are racial differences in IQ due to differences in innate intellectual ability or to cultural variations in exposure to particular information? There is no agreed upon answer to the controversial issue of the source of racial differences in IQ. As Sternberg, Grigorenko, & Kidd (2005) note, we first need to know what intelligence is to understand the source of racial differences in IQ. Cooper (2005) agrees that new theoretical approaches to the question of the sources of racial equality in IQ are needed. In this research, we offer a theoretically guided, experimental approach to the question of the basis of racial differences in IQ.

Jensen (1998) assumes that the opportunity for exposure to the information being tested on conventional IQ tests has been the same for all races. Given that assumption, Jensen attributes racial differences in IQ to differences in basic intellectual ability. In contrast to Jensen, Fagan assumes (Fagan, 1984; 1991; 1992; 2000; Fagan & Haiken-Vasen, 1997) that the IQ score is a measure of knowledge. How much a person knows (their IQ) depends on the person's information processing ability (their intelligence) and on the information the person has been given to process. In this view, if group differences in IQ are not accompanied by group differences in information processing ability, then the search for the causes of the IQ differences should be directed toward differences in access to information.

Fagan and Holland (2002) investigated the contributions intellectual ability and access to information make to racial differences in IQ. The African Americans and Whites in the Fagan and Holland (2002) studies were highly representative of the U.S. population with regard to age and education (U.S. Census Bureau, 1999). Moreover, the IQs of the participants in the Fagan and Holland (2002) studies were representative of the IQs of Whites and African Americans in the U.S. population. These young adults were compared for their knowledge of the meanings of words, a task commonly used on standard IQ tests and, most importantly, a task that typically results in racial group differences in IQ. Fagan and Holland (2002) ensured that the African Americans and Whites were given equal opportunity to learn the meanings of novel words and conducted tests to determine how much knowledge had been acquired. For example, participants might be exposed to a sentence such as "Tubby had a big fat venter" and asked to indicate

whether a “venter” was a body part or a mental state. On a later test of vocabulary knowledge, the word "venter" would be presented with: “a. height, b. candle, c. badge, d. belly, and e. opening” as choices.

If, as Jensen suggests, racial differences in IQ are due to differences in intellectual ability per se, then knowledge for word meanings learned under exactly the same conditions should differ between African Americans and Whites. However, if differences in IQ between races are due to unequal opportunity for exposure to information, rather than to differences in intellectual ability, no differences in knowledge should be obtained between African Americans and Whites given equal opportunity to learn new information.

Fagan and Holland (2002) controlled for the possibility that the particular people chosen to represent each racial-ethnic group might, by chance, simply have been equal in vocabulary knowledge initially. Thus, the tests of a person's knowledge of the newly learned words were intermixed with similar multiple choice tests for knowledge of the meanings of different words, words for which no special training in the experimental situation had been provided, such as those typically used in vocabulary tests of IQ.

In accord with the general literature, it was assumed that the racial-ethnic groups would differ in knowledge of the meanings of words taken from standard IQ tests. The question was whether they would differ in their knowledge for newly learned words. The Whites were, as expected, superior to the African Americans in untrained vocabulary knowledge. Conversely, when equal opportunity for exposure to the meanings of words was experimentally assured, the Whites and the African Americans were equal in vocabulary knowledge. Thus, if members of different racial groups are given equal opportunity to acquire the meanings of words, their knowledge of the meanings of these words does not differ. Fagan and Holland (2002) concluded that African Americans and Whites do not differ in the ability to process new information and that the search for racial differences in knowledge (IQ) should be aimed at differences in the information to which people from different racial groups have been exposed.

A further study (Fagan & Holland, 2007) explored the generality of the Fagan and Holland (2002) findings. African Americans and Whites were tested for their knowledge of sayings, analogies, or similarities. Material was presented in such a way that knowledge of the concepts and terms employed in each test were commonly available for individuals of either race. Participants also were tested for their understanding of sayings, similarities, and analogies as typically given in assessments of IQ. Knowledge of sayings, similarities, and analogies are commonly used measures of IQ and vary with race (Jensen, 1980; 1981). As in the Fagan and Holland (2002) study, knowledge such as that tested on conventional IQ tests varied with race, while knowledge based on information made generally available did not vary with race.

In brief, the data of Fagan and Holland (2002, 2007) support the view that cultural differences in the provision of information account for racial differences in IQ. Specifically, the results indicate that IQ differences among races have to do with experience. The present research

focuses on the implications that the results of the Fagan and Holland studies have for the development of a valid, culture-fair test of intelligence.

The authors of standard intelligence tests assume that a person who knows more than another person about particular information (such knowledge being predictive of achievement in that culture) is the more intelligent person. As Sternberg (2000) points out, the processes of intelligence may be the same from culture to culture, but a person is called more or less intelligent based on socially approved standards of what is important to know. Sternberg goes on to note that confusing intelligence with what society says is intelligent may cause us to give up on people who have basic abilities that go unrecognized. Sternberg's observations have much merit. The chief practical implication of the Fagan and Holland studies noted above is that it may be possible to develop culture-fair tests of intelligence that will allow basic intellectual abilities to be recognized. Specifically, the inequality of educational achievement among races in our country has highlighted a need for culture-fair tests of intelligence. African Americans do not do as well as Whites on IQ tests and other tests of knowledge, such as the Scholastic Assessment Test and the Graduate Record Exam. Basing admission to higher education on such test scores means that only a small percentage of Blacks are eligible for admission to colleges and universities. A culture-fair test of intelligence would allow basic abilities to be measured and would allow those with appropriate intellectual skills to pursue further schooling.

Jensen (2000) believes that it may not be possible to come up with tasks that show no differences in test performance between African Americans and Whites and yet still predict academic performance. Fagan (2000) does not agree with Jensen, pointing out that the failure to develop tests of intelligence that can be fairly applied across racial groups stems from a theoretical bias to equate the IQ score with intelligence rather than with knowledge. If intelligence is defined as information processing and the IQ score as knowledge, the possibility of culture-fair tests of intelligence based on estimates of information processing arises. Fagan is not alone in such a conjecture. Williams (2000, p.17) notes that "Fagan's ideas" (Fagan 2000) of measuring thinking or information processing rather than accumulated knowledge are "relevant to the debate on intelligence testing and affirmative action because . . . a true measure of processing efficiency (if it could be devised) would be fair to members of all racial and ethnic groups."

In the present research, college students were tested for their ability to acquire new information concerning the meanings of previously unknown words, sayings, similarities, and analogies. They also were tested for their knowledge of vocabulary in general, opposites, and analogies via a brief version of the verbal section of the Scholastic Assessment Test (SAT-V) constructed for the purposes of the present research. For a small number of the participants, standard SAT-V scores were available. Numerical grades in courses were obtained for the majority of the participants. Associations among performance on the culture-fair tests of new learning, academic aptitude (the brief SAT), and academic achievement (objective test scores in college courses) were analyzed. The goal of the present investigation was to discover if a culture-fair test of intelligence based on new learning is predictive of academic achievement. New learning was chosen to test information processing ability because African Americans and

Whites, as we have noted, do not differ on such ability. Yet, as Fagan and Holland found, such new learning is predictive of scores on standard IQ tests. Practically, measuring new learning of initially unknown terms allows for a wealth of items for the creation of alternate forms of culture-fair tests of new learning.

Experiment 1

The purpose of an initial experiment was to test the predictive validity of a culture-fair, racially unbiased, test of intelligence. Specifically, the purpose was to discover if a culture-fair test of intelligence based on learning the meanings of new words, sayings, similarities, and analogies is predictive of both a standard assessment of scholastic aptitude and of academic achievement.

Participants

A sample of 484 students (266 females, 218 males, 436 Whites or Asians and 48 Blacks or Hispanics) with a mean age of 20.15 years (SD 4.1 years) and a mean education of 14.1 years (SD 1.4 years) took part in Experiment 1. A total of 386 of the students were enrolled at private universities (337 at one and 49 at another), 22 attended a local college, and 46 attended a two-year community college. All participants were registered for psychology classes. Specific demographic characteristics were gathered by asking students to complete a form that asked for their age, gender, and years of education. Racial identity was voluntarily provided by the students, who read and filled out a form stating: "According to the United States Public Health Service, 'women and members of minority groups and their subpopulations must be included in all National Institutes of Health supported biomedical and behavioral research,' and researchers are asked to 'describe the composition of the proposed population in terms of gender and racial/ethnic group.' To aid us in following the US Public Health Service guidelines for research, please check the appropriate category." The student then checked one of five categories labeled "American Indian or Alaskan Native," "Asian or Pacific Islander," "Black, not of Hispanic origin," "Hispanic," or "White, not of Hispanic origin."

Materials

Materials included a culture-fair test of the students' ability to acquire new information concerning the meanings of previously unknown words, sayings, similarities, and analogies. Examples will be noted below. In addition to the culture-fair tests of new learning, all participants were given a brief SAT-type test based on questions available from a variety of books containing practice questions for the SAT. (Again, examples will be given below). The brief SAT was given to ensure that all participants would be given the same test, since standard SAT scores from the community college students could not be obtained (they are not required to take such tests for admission). In addition, students from other countries and transfer students did not always have SAT scores on record. Standard SAT-V scores were available for 291 of the students at one of the participating universities. Measures of specific academic achievement (exam performance on objective tests) were obtained from instructors of Psychology courses

who were asked to provide the students' numerical scores on the tests in the course. Such tests tended to be objective tests (multiple choice and true-false questions) based on lectures and readings. Grades were obtained from one Psychology class per participant, typically classes in Introductory Psychology, and were usually based on some 200-300 items across tests during a semester.

Procedure

Culture-fair tests of new knowledge were based on a training phase and a testing phase. All training and testing was done in a group setting during set-aside class time.

Training for the learning of the meanings of new words, consisted of a form that said:

> *"Now you are going to see how some unusual words are used in sentences. Read each sentence carefully. Circle a or b to answer the question that follows each sentence."*
>
> *It cost 1,500 bezants to buy the rug in Byzantium. BEZANT is: a. an action b. an object*

Training would then continue for the remaining six words of the seven-item set. Instructions and one example of training for learning the meaning of new sayings follow:

> *"On the following pages you will see how 8 sayings from various cultures are explained in English. Carefully read the explanation for each saying. Then circle the number from 1 to 5 that indicates how well you, yourself, now understand the saying from the explanation. Please rate your own understanding of each saying from the explanation given."*
>
> *IN THE SOUP: Stuck. Not able to escape. Can't get away.*
>
> *1 2 3 4 5*
>
> *I understand: very well don't understand*

Training for learning the meanings of new similarities and for analogies was accomplished using pairs of nonsense words. Each of 10, two-word sets was explained. Later, each pairing of words was used to test for the similarity between the words and how the same words fit into an analogy. The training instructions and one example follow:

"On the following pages you will see how simple words from rare languages are explained in English... Carefully read the explanation for each set of words. First circle either a or b for the question given after the explanation. Then circle the number from 1 to 5 that indicates how well you, yourself, now understand the meanings of the words from the explanation. Please rate your own understanding of each set of words from the explanation given."

BRILLIG and CIDY: a BRILLIG is easily picked from a low branch and a CIDY from off a vine. Both a BRILLIG and a CIDY are juicy and delicious.

BRILLIG and CIDY are good to a. Eat b. Swim in

1 2 3 4 5

I understand: very well don't understand

Following training, the students handed in their training materials and then received a set of tests on the newly learned material. Specifically, to test new knowledge of the seven word meanings, the student was asked to:

"Circle the letter (a, b, c, d) next to the word that you think is the correct definition of the term. Do the best you can and give an answer for every question."

BEZANT a. hotel b. coin c. mill d. harbor

To test new knowledge for the sayings, the student was told:

"We would like to find out what people know about the meanings of sayings." For example:

AN APPLE A DAY KEEPS THE DOCTOR AWAY means

a. Eating good food helps you to stay healthy b. Pay your debts

"That's right. The answer is a. Eating good food helps you to stay healthy. Here are eight such sayings. Please circle what you believe to be the correct answer for each question."

IN THE SOUP means a. Broke b. Rich c. Trapped d. Knowing

To test for knowledge of newly learned analogies and similarities, the student was told:

"On the following pages we will be asking how one pair of words is similar to another pair of words. You will be putting a circle around the letter in front of the correct answer." For example:

HIGH is to TALL as LOW is to _____ a. SHORT b. RED

"That's right! The answer is SHORT. On the following pages you will see 10 pairings that have to do with how one pair of words is most like another pair of words. Please circle the letter you consider to be the correct answer. Also on the following pages, we will be asking how one word is most like another word. You will be putting a circle around the letter in front of the correct answer." For example:

MAN and WOMAN a. HUMAN b. LIVING c. AMERICAN

"The answer is a. HUMAN. Why? Because HUMAN is the way in which MAN and WOMAN are MOST alike. Don't skip any questions. If you are not sure, make your best guess."

On the following pages, students saw 10 pairs of questions such as:

"BRILLIG is to CIDY as TREE is to_____	*BRILLIG and CIDY*
a. Grass	*a. Round*
b. Vine	*b. Colored*
c. Tea	*c. Fruit*
d. Ocean	*d. Vitamins"*

Questions of the sort traditionally tested on the SAT-V were taken from practice tests for the SAT-V (Robinson & Katzman, 2003) and the GRE (Martinson, 2000) to comprise what we will refer to as the brief SAT. The test included 24 items, 8 of which tested knowledge of the meanings of words. For example:

"Directions: Each of the questions below contains one or more blank spaces, each space indicating an omitted word. Each sentence is followed by five words or sets of words. Read and determine the general sense of the sentence. Then chose the word, or set of words that, when inserted in the sentence, best fits the meaning of the sentence."

Henry viewed Melissa as_____; she seemed to be against any position regardless of its merits.

a. heretical b. disobedient c. contrary d. inattentive e. harried

A second set of eight questions tested knowledge of opposites. For example:

"Directions: Each of the following questions consists of a word printed in capital letters, followed by five words or phrases. Choose the word or phrase that is most nearly opposite in meaning to the word in capital letters. Consider all the choices before deciding which one is best."

EXONERATE a. testify b. engender c. accuse d. inundate e. abrogate

A third set of eight questions tested knowledge of analogies. For example:

"Directions: In each of the following questions, you are given a related pair of words in capital letters. Each capitalized pair is followed by five (5) pairs of words. Choose the pair that best expresses a relationship similar to that expressed by the original pair."

WATERFALL: CASCADE::
a. snow: freeze b. missile: launch c. tree: exfoliate d. wave: undulate e. monarch: reign

Time

An entire session, including training and testing, lasted about 35 minutes.

Results

Data on the acquisition of new knowledge was based on the student's total score across tests of word meaning, meanings of sayings, knowledge of similarities, and knowledge of analogies. Total scores based on the brief SAT type tests of knowledge of meanings, opposites, and analogies described above were the second variable of interest. Finally, numerical grades in class constituted the measure of achievement.

The initial question was whether, in accord with earlier findings (Fagan & Holland 2002, 2007), the minority group members and the majority group members in the present research differed in performance on standard indices (SAT-type questions and class grades) which rely on past knowledge of word meanings, but did not differ in knowledge of newly learned material. Of the 48 minority members in the sample, 42 were students at one private university. These 42 students were compared with the 295 remaining students from that same university for new learning, SAT-type performance, and academic achievement. Table 1 lists the mean scores for each measure for each racial group along with the *t* values resulting from comparisons of the racial groups on each variable.

Table 1
New Knowledge, Brief SAT, and Grades for Racial Majority and Minority Group Members and Associated t Values

	Race	Mean	SD	*t*	*P*
New Knowledge	Majority	26.9	5.1	0.2	n.s.
	Minority	27.0	4.4		
Brief SAT	Majority	15.8	4.3	2.1	<.05
	Minority	14.3	5.1		
Class Grades	Majority	84.3	9.0	3.9	<.001
	Minority	77.9	14.2		

The present findings are in accord with earlier results. Minority and majority group members did not differ in knowledge when equal opportunity for previous exposure to information was experimentally controlled (tests of new knowledge). They did differ when previous exposure to information was not controlled (brief SAT and class grades). For our present purposes, the results in Table 1 confirm the culture-fair nature of the items chosen to measure new knowledge.

The next question is what are the relationships among the indices of new knowledge, SAT-type scores and class grades? In determining these relationships, correlations were computed among variables. Both the uncorrected correlations and the correlations corrected for unreliability were reported. The means and standard deviations for the test of new learning, the brief SAT test, and class grade along with estimates of reliability based on Kuder-Richardson formula 21, (Cronbach, 1960) are listed in Table 2 for the total sample of 484 participants.

Table 2
Estimates of Reliability for New Knowledge, Brief SAT Scores, and Grades

	Mean	SD	% correct	Reliability
New Knowledge	25.6	5.7	73.1	.81
Brief SAT	14.2	5.1	59.2	.81
Class Grade	83.4	8.2	83.4	.86

Note. N = 484.

Table 3 lists the obtained coefficients, both uncorrected and corrected for attenuation due to unreliability, for the total sample of 484 participants in the initial effort.

Table 3
Correlations Among New Knowledge, Brief SAT, and Grades, Uncorrected (r) and Corrected (R) for Unreliability

	Brief SAT	Grades
New Knowledge	*r* .58*	*r* .19*
	R .72*	*R* .23*
Brief SAT		*r* .29*
		R .35*

Note. N = 484, *p < .01.

The most relevant information to note from the data given in Table 3 is that scholastic achievement was predicted at a low but statistically significant level by a culture-fair test of new knowledge and that there was a substantial and significant relationship between the culture-fair test of new knowledge and the Brief SAT index. The coefficients obtained between grades and new knowledge noted in Table 3, however, may be attenuated in at least three ways. The first is that the 35-item test of new learning proved to be quite easy at 73.1% correct as compared to 59.2% correct for the brief SAT. A more difficult test of new learning might result in better predictive validity. The second fact contributing to attenuation is variability in grading from school to school or from class to class within a school (i.e., teachers vary in how they grade). The third fact is that the majority of the participants in Experiment 1 (70%) were drawn from one private university with very high admission standards. Among the total sample in Experiment 1, however, we were fortunate to obtain grades from the same teacher who taught the same course at both a community college and a 4-year college. The two classes included 68 students. Table 4 presents the means and standard deviations for the tests of new learning, the brief SAT tests, and class grades for those 68 participants along with Kuder-Richardson reliabilities for each measure.

Table 4
Estimates of Reliability, Means, and SDs for New Knowledge, Brief SAT Scores, and Grades

	Mean	SD	% correct	Reliability
New Knowledge	23.0	5.6	66.0	.77
SAT	10.3	4.5	43.0	.74
Class Grade	84.4	8.2	84.4	.81

Note. N = 68.

The coefficients, uncorrected and corrected for unreliability, between scores on the culture-fair test of new knowledge, the brief SAT items, and class grades for these 68 students are presented in Table 5.

Table 5
Correlations, Uncorrected (r) and Corrected (R) for Unreliability Among New Knowledge, Brief SAT Scores, and Grades

	Brief SAT	Grades
New Knowledge	*r* .58*	*r* .41*
	R .77*	*R* .52*
Brief SAT		*r* .55*
		R .70*

Note. N = 68, *p < .01.

As one can see, when a common metric for grades is available and range of ability is increased, the relationship between the test of new knowledge and either the brief SAT test or performance in class is substantial. One might also note that the relationships noted in Tables 3 and 5 between the brief SAT and class grades are higher than the relationships between new learning and class grades. Such a disparity is to be expected. Processing ability (measured here by the new learning task) plays a role in how much knowledge is gained over time, hence new knowledge predicts both brief SAT scores and grades. The brief SAT scores, however, are based not only on processing ability but on specific information provided by one's culture. Since information provided by one's culture—information necessary to solve items on the brief SAT (e.g., knowledge of word meanings)—also plays a role in understanding course material; one would expect the brief SAT scores to be somewhat better predictors of grades than the new learning scores.

Finally, in employing the brief SAT test constructed for the present effort, we wanted a measure comparable to the standard SAT-V as to predictive validity for scholastic achievement. A subset of 294 of the 484 students who participated in Experiment 1 attended the same private university. These 294 students had taken the SAT in 2003-2004 allowing a direct comparison between the brief SAT constructed for the present research and conventional SAT-V scores. The two estimates were themselves highly correlated at $r = .73$ with a correlation corrected for unreliability (R) of .86. Table 6 describes how these 294 students performed on the SAT-V and the brief SAT test and class grades along with Kuder-Richardson 21 reliabilities for each measure.

Table 6
SAT-V Scores, Brief SAT Scores, Grades, and Reliability Estimates

	Mean	SD	Reliability
SAT-V	630.9	86.1	.92
Brief SAT	15.4	4.7	.78
Grades	83.5	9.4	.85

Note. N = 294.

As one can see from the data in Table 6, the students, as a group, scored highly both in academic (83.5%) and in conventional aptitude test performance (630.9 on the SAT-V). How well did the SAT-V and the brief SAT test predict academic achievement? The predictive validity coefficients, corrected (*R*) or not corrected (*r*) for unreliability, are listed in Table 7.

Table 7
Prediction of Grades on the Basis of the SAT-V and the Brief SAT, Uncorrected (r) and Corrected (R) for Unreliability

	Grade
SAT-V	r = .28*
	R = .30*
Brief SAT	r = .25*
	R = .31*

Note. N = 294, * p < .01.

As is evident from the data listed in Table 7, both the SAT-V and the brief SAT test were successful in predicting academic performance. All values were significantly greater than chance and of moderate scope. Of most importance is the fact that the predictions from each test to academic performance were virtually identical. No significant differences were found between the SAT-V predictions of class grade or the brief SAT test's prediction of class grade. Whether such similarities in prediction may be influenced by restriction of range remains a question for further study.

Experiment 2

The results of Experiment 1 indicated that the tests of new learning, developed to that point, were culture-fair, reliable, and predictive of both numerical grades in class and of performance on tests akin to standard tests of scholastic aptitude (brief SAT sores). Experiment 2 involved a much higher percentage of community college students relative to those in private universities and colleges than was possible for Experiment 1. Such sampling allowed a more representative estimate of performance on new learning tests, the brief SAT, and academic achievement. In the construction of any test, some items are found to be more predictive than

others. We analyzed the data from Experiment 1 to determine which items from the culture-fair test of new learning would be most predictive and of moderate difficulty level. We retained those items in a revised version of the test and added additional, new items which appeared to be of equal difficulty to the selected items. These modifications to the sample and test characteristics allowed a more accurate determination of the reliability and predictive validity of the culture-fair test of new learning.

Participants

The sample included 696 students (425 females, 271 males). Those of majority ethnic status constituted 78% of the sample and those of minority ethnic status 22%. The mean age of the participants was 21.2 years (SD 5.8 years). The mean education was 13.7 years (SD 1.3 years). Some 52% of the students were enrolled at private universities (40% at one and 12 % at another), 2% attended a local college, and 45% attended a two-year community college. All participants were registered for psychology classes. Specific demographic characteristics were again gathered by asking students to complete a form that asked for their age, gender, and years of education. Racial identity was again determined by the students who filled out the United States Public Health Service form noted earlier.

Materials

Participants were given the same, 24-item, brief SAT test used in Experiment 1. Standard SAT-V scores were available for 213 of the students at the participating universities. Measures of specific academic achievement (exam performance on objective tests) were obtained from instructors of Psychology courses who were asked to provide the students' numerical scores on the tests in the course. An extended, 48-item culture-fair test of the students' ability to acquire new information concerning the meanings of previously unknown words, sayings, similarities, and analogies was given in Experiment 2 and will be noted below.

Procedure

As before, the tests of new knowledge were based on a training phase and a testing phase with all training and testing done in a group setting during set-aside class time. Training for the learning of the meanings of new words, sayings, similarities, and analogies followed the same format used in Experiment 1. In Experiment 2, participants learned the meanings of 12 new words and 16 new sayings. Training for learning the meanings of new similarities and for analogies was accomplished using 20 pairs of nonsense words. Following training, the students handed in their training materials and then received a set of tests on the newly learned material. The tests for how well the meanings of new words and sayings were learned followed the same format as employed in Experiment 1. The testing for how newly learned nonsense words could be used in solving similarities and analogies differed from the testing procedure employed in Experiment 1. In Experiment 2, 10 pairs of nonsense words of the 20 that had been learned were used to test knowledge of similarities and the remaining 10 pairs of learned nonsense words were

used to test knowledge of analogies. An entire session (training and testing) lasted about 45 minutes.

Results

As in Experiment 1, data on the acquisition of new knowledge was based on the students' total score across tests of newly acquired meanings of words, sayings, similarities, and analogies. Total score based on the brief SAT-type tests of knowledge of meanings, opposites, and analogies was the second variable of interest and numerical grades in class constituted the measure of achievement.

The first focus was on questions concerning the role of racial-ethnic minority status in the relationships among knowledge of newly learned material, past knowledge as estimated by the brief SAT scores, and grades in class. These questions were explored in a series of multiple regression analyses. The first two of these analyses were based on 692 participants for whom scores on new learning and the brief SAT were available and who had indicated their ethnic status. According to the theory guiding the present research, one would expect both racial-ethnic status and new learning ability to play a role in past knowledge as reflected in brief SAT scores. Indeed, such was the case. The regression analysis yielded a multiple R of .64, F (2,690) = 236.6, $p < .001$, with Beta values of .08 ($t = 2.7$, $p < .01$) and .62 ($t = 21.0$, $p < .001$) for minority status and new learning, respectively, for the prediction of brief SAT scores. Most importantly for our present purposes, however, one would expect past knowledge (i.e., brief SAT scores), but not racial-ethnic status to be related to the ability to process new information. The results were as expected. The regression analysis yielded a multiple R of .63, F (2,690) = 231.3, $p < .001$, with Beta values of .03 ($t = 0.9$, *n.s.*) and .63 ($t = 21.0$, $p < .001$) for minority status and brief SAT scores, respectively, for the prediction of new learning.

A similar analysis was undertaken for the contributions of racial-ethnic status and new learning ability to academic achievement. These analyses were based on 593 participants for whom scores on new learning and class grades were available and who had indicated their ethnic status. Again, one would expect both racial-ethnic status and new learning ability to play a role in academic achievement. They did, with a multiple R of .36, F (2,591) = 44.4, $p < .001$, with Beta values of .08 ($t = 2.0$, $p < .05$) and .35 ($t = 9.7$, $p < .001$) for minority status and new learning, respectively, for the prediction of grades. Achievement and new learning ability would undoubtedly be related. But does racial-ethnic status contribute any independent variance to the prediction of new learning ability once the association between new learning ability and achievement is taken into account? No, a regression analysis incorporating racial-ethnic status and achievement as predictors of new learning ability yielded a multiple R of .35, F (2,591) = 42.4, $p < .001$, with Beta values of .03 ($t = 0.7$, *n.s.*) and .35 ($t = 9.1$, $p < .001$) for minority status and grades, respectively, for the prediction of new learning.

The present findings are in accord with the results of Experiment 1 where minority and majority group members did not differ in knowledge when equal opportunity for previous exposure to information was experimentally controlled (tests of new knowledge). The groups of

different racial-ethnic background did differ when previous exposure to information was not controlled (brief SAT and class grades). For our present purposes, the results of both experiments confirm the culture-fair nature of the items chosen to measure new knowledge.

The relationships among the indices of new knowledge, SAT-type scores, and class grades, both uncorrected and corrected for unreliability, for 596 participants in Experiment 2 will now be considered. Table 8 lists means and standard deviations for the test of new learning, the brief SAT test, and class grades along with estimates of reliability based on Kuder-Richardson formula 21.

Table 8
Estimates of Reliability for New Knowledge, Brief SAT Scores, and Grades

	Mean	SD	% correct	Reliability
New Knowledge	25.5	7.1	53.2	.78
Brief SAT	11.6	5.3	48.4	.82
Class Grade	81.0	12.2	81.0	.90

Note. N = 596.

Testing in Experiment 2 involved a much higher percentage of community college students relative to those in private universities and colleges than was possible for Experiment 1, allowing a more representative estimate of performance on new learning tests, the brief SAT, and academic achievement. The sampling procedures in Experiment 2 succeeded in providing greater variability in scores for new knowledge, the brief SAT, and grades than was the case in Experiment 1. Similarly, the addition of items to the test of new knowledge in Experiment 2 resulted in scores similar in difficulty to the brief SAT scores. These modifications to sample and test characteristics allowed a more accurate determination of the reliability and predictive validity of the culture-fair test of new learning. The obtained coefficients, either uncorrected or corrected for attenuation due to unreliability, for the total sample of 596 participants are listed in Table 9.

Table 9
Correlations Among New Knowledge, Brief SAT, and Grades, Uncorrected (r) and Corrected (R) for Unreliability

	Brief SAT	Grades
New Knowledge	*r* .63*	*r* .36*
	R .79*	*R* .43*
Brief SAT		*r* .46*
		R .53*

Note. N = 596, * p < .01.

The most relevant information to note from the data given in Table 9 is that scholastic achievement is predicted at a moderate and statistically significant level by a culture-fair test of new knowledge and there is a substantial and significant relationship between the culture-fair test of new knowledge and the brief SAT index. The coefficients obtained between grades and new knowledge noted in Table 9 are considerably greater than those obtained in Experiment 1, because a more difficult task of new learning ability was employed in Experiment 2 and the participants in Experiment 2 were drawn from a more representative sample of institutions of higher education than was the case in Experiment 1. Variability in grading from school to school and from class to class within a school remained as an attenuating factor in assessing the accuracy of predictive validity coefficients. As noted in the analyses of Experiment 1, when a common metric for grades is available (the same teacher for the same course in both a college and a community college) and range of ability is increased, the relationship between the culture-fair test of new knowledge and either the brief SAT test or performance in class is substantial.

As also noted in Experiment 1, and again in Experiment 2, the relationships between the brief SAT and class grades are somewhat higher than the relationships between new learning and class grades. Again, this disparity is to be expected because learning ability plays a role in knowledge acquisition and, thus, predicts both brief SAT scores and grades. However, the past information provided by one's culture also determines performance on the brief SAT and the understanding of course material. Hence, the brief SAT scores are somewhat better predictors of grades than the new learning scores alone.

A further multiple regression analysis assessed if the test of new knowledge, being highly correlated with the brief SAT, would add variance to the prediction of grades, variance independent of that predicted by the brief SAT scores. The test of new learning did add independent variance to the prediction of grades as indicated by a multiple R of .47, F (2,593) = 82.9, $p < .001$, with Beta values of .11 ($t = 2.4$, $p < .02$) and .39 ($t = 8.3$, $p < .001$) for new learning and the brief SAT, respectively, for the prediction of grades.

Experiment 2 also allowed a further estimate of whether the brief SAT employed in the present experiments was comparable to the standard SAT-V as to predictive validity for scholastic achievement. Experiment 2 included 213 students attending two private universities who had taken the SATs in 2005-2006. The 213 students included 109 males, 104 females, 189 racial-ethnic majority group members, and 24 racial-ethnic minority group members with an average age of 19.3 years, SD 1.6. Table 10 presents a description of how these students performed on the SAT-V and the brief SAT test along with their class numerical grades.

Table 10
SAT-V Scores, Brief SAT Scores, Grades, and Reliability Estimates

	Mean	SD	Reliability
SAT-V	610.8	87.2	.98
Brief SAT	14.8	4.4	.74
Grades	85.2	9.3	.86

Note. N = 213.

The brief SAT and the SAT-V scores were themselves again correlated at $r = .75$ with a correlation corrected for unreliability (R) of .88. Again, the main focus of the analysis was on how well the SAT-V and the brief SAT test predicted academic achievement. The predictive validity coefficients, corrected (R) and not corrected (r) for unreliability, for the participants in Experiment 2 are listed in Table 11.

Table 11
Prediction of Grades on the Basis of the SAT-V and the Brief SAT, Uncorrected (r) and Corrected (R) for Unreliability

	Class Grade
SAT-V	$r = .35$*
	$R = .38$*
Brief SAT	$r = .33$*
	$R = .41$*

Note. N = 213, * p< .01.

As you can see from the data in Table 11, both the SAT-V and the Brief SAT test were again successful in predicting academic performance. Once more, the predictions from each test to academic performance were virtually identical. No significant differences (via *t* tests) were found between the SAT-V predictions of class grade or the brief SAT test's prediction of class grade.

DISCUSSION

Summary

The present research addressed the question of whether a racially unbiased test of the ability to process information would predict how well young adults succeed in college classes. Current theories of intelligence are based on an assumption that all those taking IQ tests have had equal opportunity for exposure to the information being tested. Thus, past efforts to develop an intelligence test that is culture-fair have not been successful. The present research is based on a theory (Fagan, 1992, 2000) that assumes that we act on the basis of what we know and that what we know is a result of our processing of the information provided to us by our culture. Based on

these assumptions, the IQ score is seen as a measure of knowledge. Specifically, how much you know (your IQ) depends on how well you process information (your intelligence) and also on the information given to you by your culture to process. The theory has been used to explain the source of IQ differences between Americans of different races. Specifically, our past research (Fagan & Holland, 2002, 2007) has found that American Whites and African Americans who differ in IQ do not differ in their ability to process information when that information has been equally accessible to both groups. In the present experiments, college students were given multiple-choice tests of their ability to acquire new information concerning the meanings of previously unknown words, sayings, similarities, and analogies. They also were tested for their knowledge of vocabulary, opposites, and analogies with a brief version of the SAT-V constructed for the present experiments. The brief SAT provided a standard measure of academic aptitude that would be common to both community college students and university students. Numerical grades in courses were obtained for the majority of participants. Associations among performance on the culture-fair tests of new learning, academic aptitude (the brief version of the Scholastic Assessment Test scores), and specific achievement (objective test scores in college courses) were analyzed.

The findings reveal that tests of new learning are culture-fair, reliable, and predictive of both academic achievement (numerical grades in class) and of a brief version of a standard test of scholastic aptitude (the Scholastic Assessment Test-Verbal). Further, the results demonstrate that tests of new learning and tests of existing knowledge (such as the brief SAT) each contribute independent variance to the prediction of class grades. A final notable finding is that the brief, 24-item version of the SAT-V that was created for the present investigation turned out to be as predictive of college grades as the standard SAT-V. In summary, the present research indicates there are at least two factors that determine success in a complex learning environment such as higher education: one is information processing (new learning) ability and the other is the extent of knowledge one has acquired to that point.

Theoretical Significance

Jensen (1998) believes that the IQ score reflects what he calls the general factor (or *g*) underlying intelligence. Differences in IQ scores are due to differences in *g*. According to Jensen, genetic factors play a primary role in determining *g*. Thus, Jensen (2000) believes that it may not be possible to come up with tasks that show no differences in test performance between African Americans and Whites and yet still predict academic performance. Fagan (2000) does not agree with Jensen, pointing out that the failure to develop tests of intelligence that can be fairly applied across racial groups stems from a theoretical bias to equate the IQ score with intelligence rather than with knowledge. If intelligence is defined as information processing and the IQ score as knowledge, the possibility of culture-fair tests of intelligence based on estimates of information processing arises.

The chief theoretical implication of the results of the present research is that the assumption of equal opportunity for exposure to information made by theories of intelligence is false. When such an assumption is shown to be false, it becomes possible to develop culture-fair

tests of intelligence that allow basic intellectual abilities to be recognized. The present findings and those of Fagan and Holland (2002, 2007) are consistent with other studies that have attempted to provide equal opportunity for exposure to information to people of different races. In an early study, Bridgeman and Buttram (1975) found that training verbal strategies erased the differences between African American and White school children on tests of analogy solutions. More recently, Sternberg et al. (2002) showed that teaching cognitive skills and strategies to African children in Tanzania increased their scores (relative to children not so trained) on tests of syllogisms, sorting, and twenty questions. Finally, Skuy et al. (2002) found that Black college students in South Africa given a mediated learning experience reaped significantly more benefit from such training on tests of matrix solution than did similarly trained White peers.

In brief, the present experiments serve as an example of how a long-lived and currently much debated issue such as culture-fair tests of intelligence can be addressed by a theory which defines intelligence as information processing and by experimental studies guided by such a theory. The present results also contribute to two main theoretical goals of the ARI basic research program: to discover relationships among information processing ability and knowledge that lead to achievement and productivity in complex situations and to demonstrate that *intelligence is a function of an aptitude* [learning ability in novel situations] *that cuts across domains and how to develop a method for measuring this aptitude* [and to further] *validate* [this] *cognitive ability against relevant criteria* (BRO-BAA, page 5, III, D, 1). In future work it also might be informative to conduct research on the long-term retention of newly gained knowledge, to see if the ability to retain new knowledge is as predictive as or even more predictive of relevant achievement criteria than the ability to encode new information. In the present research, achievement was based primarily on performance in introductory classes in Psychology. Future work might investigate the role of new learning ability on achievement in other academic specialties and in classes ranging from introductory to advanced. Such studies would aid in clarifying the relative impact of new learning ability and prior exposure to information on academic performance in general.

Practical Implications

We know that there exists a sizable gap in SAT or ACT scores between students of majority or minority racial-ethnic status (Zwick, 2002). One solution to the disparity in admission rates to college due to race is to abandon tests such as the SAT or ACT. Such a solution is impractical and is unlikely to be adopted by the majority of institutions of higher learning. Another solution is to develop culture-fair, valid tests of academic aptitude that may be used in place of, or more likely, in addition to conventional tests such as the SAT or ACT. Initial attempts at the development of such a culture-fair test have been met with limited success (Sternberg, 2006). The present experiments, however, provide evidence that brief, reliable tests of information processing based on the ability to acquire new information are valid predictors of academic achievement and do not discriminate between groups differing in racial-ethnic status.

Two of the guiding missions of ARI, both historically and currently, are to provide new technology to meet the personnel challenges of the Army in recruiting, selecting, and assigning

quality people and to provide scientific insight into leader development. The present research provides basic scientific data to aid in *Soldier selection, assignment, and performance* and in *leader development.* Specifically, the results of the present research aid the Army in measuring individual differences in cognitive ability without regard to racial-ethnic status. Such estimates of cognitive ability (based on brief, cost-effective tasks) can be used in the selection of Soldiers and in the identification of mature, effective leaders. Tests of information processing ability that are valid predictors of achievement in complex situations provide a means to evaluate volunteers and select candidates for advanced education or training in complex situations of the sort performed by Army personnel. Such tests also can be employed in further selection and training stages. In the field, such skills are necessary to make quick and correct decisions based on rapidly incoming information. Skill in information processing is likely to be a key indicator of effective future Army leaders. Finally, using tests of information processing known to be culture-fair may provide an increase in the number of eligible recruits and an incentive to re-enlistment on the part of minorities.

Currently, questions have been raised in a series of articles in the *New York Times* (e.g., Lewin, 2006) about the amount of time necessary to complete the SAT, which is estimated at 3 hours and 45 minutes (and longer for students with disabilities). Earlier reports in the *New York Times* (e.g., Arenson, 2005) revealed a sizable error rate in the current scoring process for the SAT. The findings of the present research as to the predictive validity of a brief SAT have practical implications for the use of lengthy tests of aptitude in general. In the present, ARI-sponsored, research we found that a very brief, easily scored version of the SAT-V was as predictive of college grades as the standard SAT-V. Data on predictive validity relative to test length is an interesting empirical question to pursue in future studies and may be of benefit to the ARI applied program for Selection, Classification, and Performance Metrics for the Future Force Soldier (STO IV. SP. 2002.1).

Conclusions

In summary, the present experiments find that there are at least two factors that determine success in a complex learning environment such as higher education; one is information processing (new learning) ability and the other is the extent of knowledge one has acquired to that point. In an earlier article (Fagan, 2000, p 177), the hope was expressed that “culture-fair intelligence tests that are based on processing may provide an objective means of selecting candidates for employment or for advanced education, thus fulfilling the spirit of affirmative action and equal opportunity programs.” The present experiments show that such a hope may be a reality.

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